ATTACHMENT 4

COMMUNICATIONS EQUIPMENT

FOR

PROCUREMENT OF 40 FT LOW-FLOOR BATTERY ELECTRIC BUSES

SPECIFICATION NO. VE21-054

Massachusetts Bay Transportation Authority
Vehicle Engineering
Boston, Massachusetts

A. General

The Intelligent Transportation System (ITS) shall be provided by Vontas or Authority approved equal. The ITS shall be compatible in all respects with the existing MBTA Communications System. The system shall comprise of the latest proven and tested models. All new technology developments and/or software updates shall be submitted to the Authority for review and upon approval shall be incorporated into the final design. A complete system integration plan shall be submitted to the Authority during the Design Review Process for approval.

The following paragraphs comprise the Intelligent Transportation System (ITS) specifications for this procurement:

B. Bus Public Address, Audio and/ Visual Next Stop & Destination Announcement System (PA/VMS)

A Public Address, Audio and Visual Next Stop & Destination and Announcement System with Variable Message Signs (PA/VMS) shall be installed on each bus. The system shall meet or exceed all ADA requirements found in 49CFR Parts 37.167 and 38.35 and shall provide automated audio and visual announcements to riders on-board and audio to those waiting curbside. The announcements shall be triggered by a Global Positioning System (GPS) signal. In order to maximize the system's useful life and to ensure ease of integration with third party electronics on board, the PA/VMS system shall provide a robust, open software and hardware architecture. The system shall comply with SAE J1939 vehicle communications network and data protocol so that information transmitted to and from PA/VMS components (e.g., text of a VMS message) occurs over the VLAN and can be monitored by the Cellular Gateway described in TS 79.8. The system shall have the capability of hardware and software extension to include new or additional features. The system shall also incorporate ease of programming and allow for updating all operating information.

C. PA/VMS General Description

The PA/VMS System for Authority buses shall be used to automatically provide Authority passengers with both audible and visual route, destination, next-stop, and other pertinent announcements, as follows:

- Route Number or Letter
- Destination Name
- Next Stop - Cross Street and/or Landmark
- Periodic Correct Time Announcement (Default)

The PA/VMS System shall permit the Bus Control Center Dispatcher to transmit both canned (pre-recorded) and free voice/text audible/visual messages to the bus passengers remotely from their workstations.

PA/VMS shall be fully integrated with other communication devices, both on and off the bus, through utilizing existing open communication architecture standards. The system shall include all

wiring and connectors that will be required to interface with the vehicle's voice and data mobile radio(s).

PA/VMS shall offer a low cost-of-ownership through complete and integrated database and voice processing management tools.

PA/VMS includes the following subsystems, all of which are described and/or specified in succeeding paragraphs of this specification:

- Public Address & Announcement System (PA)
- Variable Message Signs (VMS)
- Vehicle Computer Unit (VCU) and Vehicle Local Area Network (VLAN)
- Automatic Vehicle Location Subsystem (AVL)
- Operator Control Unit (OCU)
- Database Management, Recordings & Editing (DBR&E)

D. Public Address & Announcement System (PA)

1. General Requirements: The Public Address & Announcement System (PA) shall provide automatic passenger information system functionality including the capability to provide automatic interior and exterior announcements and automatically display text messages on an interior sign as required by the Americans with Disabilities Act.

   The Public Address & Announcement System (PA) shall include all necessary equipment, controllers, amplifiers, operator interface ports, speakers, sensors, cables, and hardware required to deliver a fully functional system.

   It shall accurately announce the next programmed bus stop and any special passenger information visually and audibly

2. Triggering Subsystem: The annunciator triggering subsystem shall be location-triggered rather than solely based on stop sequencing. Implementation shall not require the vehicle to stop at a bus stop (no boarding/alighting functions required as a condition for implementation). The system shall not require the opening/closing of doors or operator intervention as a condition for implementation, however door activation may be used to establish proper message sequencing at a bus stop. The GPS/AVL location subsystem is further described in Section G. The Triggering Subsystem shall initiate audio and visual messages on the bus for all system stops.

3. Annunciator Controller: The PA controller shall be part of, or interface with, the Vehicle Computer Unit (VCU). The PA controller shall be of modular design for ease of maintenance and shall be capable of expanding its message storage capacity by 50% without redesign or model change. Message storage requirements are described in Section F paragraph 2.

   The system shall be equipped with a service port, through which system diagnostics and data uploads can be accomplished. to the Authority shall be able to accomplish changes in annunciator points or annunciation messages remotely over cellular or WLAN communications.

Stored messages shall be nonvolatile, i.e., with vehicle power off or disconnected for an indefinite amount of time, stored message information shall not be lost or altered.

The Authority routinely adds, moves, or discontinues bus stops. The system provided must be able to accommodate alterations to annunciator programs using Authority personnel and without Contractor assistance. This capability shall be demonstrated.

4. Annunciator Audio: The annunciator shall be capable of playing audio announcements provided by the Authority in the form of audio files. The system shall also be able to annunciate text announcements ("robo-voice").

5. Traffic Lane Impact: The lane of travel in which the vehicle travels in the street shall not affect the annunciator operation. If the street has more than one lane of travel in a given direction, normal operation shall not be compromised if the vehicle travels in either the curb lane or the lane adjacent to the curb lane. Nor shall operation be affected by a vehicle passing another vehicle (stopped or moving) which is in the curb lane.

6. Automatic Operation: Automatic Operation shall include the following features:

   The system shall operate automatically once the operator initiates the system via the Operator Control Unit (OCU). The system shall not require operator interaction beyond the initial operator logon. All messages shall be triggered by a methodology furnished by the system.

   The system shall not initiate upcoming stop announcements until the vehicle is past the previous stop location.

   The system announcement algorithm shall be approved by the Authority and at a minimum shall provide for:

   (a) Actual announcement time

   (b) Time for a patron to physically request a stop

   (c) Operator response time to a stop request bell/buzzer

   (d) Operator execution of a safe stop

   In addition to the annunciation of all bus stops, multiple additional audio announcements (from a pre-defined population list of at least 75) shall be programmable by Authority personnel. These messages may be supplemental information such as "Service changes going into effect...", or "Seasons Greetings from MBTA". (The Authority shall be able to remotely load and program these messages onto vehicles over cellular or WLAN communications)

7. Next Stop Operating Sequence:
   Next stop announcements shall work as described below unless the Authority provides approval for an alternative operating model.

BUS STATUS	**INTERIOR MESSAGE**	**EXTERIOR MESSAGE**

Vehicle approaching next stop	(A) "STREET NAME1 at, STREET NAME2"	
Vehicle stops, door opens	(B) "STREET NAME1 at, STREET NAME2"	(C) "ROUTE ____, service to ____."

After passing the previous stop, upon reaching the trigger point for the next stop, announcement (A) shall always be made inside the vehicle. If a subsequent trigger point is reached without the driver releasing any doors to open, then announcements (B) and (C) shall not be made (No boarding or alighting were required at the announced stop).

Once announcement (A) has been made, but before reaching the trigger point of the subsequent stop, should passenger door activity occur, then:

1. If the front door is opened, announcements (B) and (C) shall be made (i.e., a boarding or an alighting patron operation is occurring) and repeated every 30 seconds;

2. If only the rear door is opened (i.e., an alighting passenger operation), then announcements (B) and (C) shall not be made. Announcements shall be made only if the front door is opened while the back door is deployed.

8. Operator Manual Control and Display:

   The Operator shall have the ability to select a message for immediate announcement and/or visual sign display by using pre-defined announcement buttons on the OCU. This shall include stop announcements (including from prior and subsequent stops) that otherwise are automatically announced as described above.

   The PA system shall automatically provide continuous information to the Operator via the OCU display regarding current and upcoming announcements. This may be integrated with other operator awareness information provided as part of the ITS.

9. Audio and Speaker Requirements: Announcement volume shall be automatically adjusted to compensate for ambient noise for both internal and external announcements. (Appropriate microphone sensors shall be installed to detect and measure ambient noise conditions. The exterior microphone sensor shall be mounted on the side of the vehicle near the vehicle's front door. The interior microphone sensor shall be mounted approximately fifteen feet back from the operator, near the top of the ceiling.) The amount and rate of volume change shall be capable of being reprogrammed by the Operator or the Authority service personnel. The maximum audio level attainable shall be sufficient to override anticipated ambient noise levels.

   The vehicle operator shall have the ability to reduce or increase the audio volume of announcements. However, the operator shall not have the ability to turn the audio volume down beyond a preset minimum level.

   The audio announcement subsystem shall have the capability to record each phrase at sampling rates of 32,000 samples per second to achieve the necessary reproduction quality. Alternately, the Authority may approve another benchmark of reproduction quality.

   Eight (8) 4 ohm speakers shall be provided and installed, evenly spaced, along the interior of the bus. In addition, one (1) speaker shall be provided and mounted outside the bus near the

front door and one (1) mounted outside the bus near each rear door, to allow communications to passengers outside the bus. Weatherproof (paper or cardboard materials are not acceptable), non-corrosive, cone type exterior speakers shall be used in all locations (exterior and interior). Speakers shall have a minimum flat response of 100-15,000Hz. The speaker installation locations, positive locking connection type, and materials shall be approved by the Authority, in advance of actual installation.

10. Public Announcement Microphone: The PA system shall include an Operator's microphone which when activated shall override any ongoing automated announcement.

    The microphone assembly shall be equipped with a switch for selecting internal, external or both speaker systems.

    A gooseneck microphone mount may be provided and placed in an area of the vehicle which shall not interfere with the Operator's windshield vision or the operation of other controls or systems in the vehicle. Other microphone arrangements may also be permitted, for test purposes, but any mounting design and location shall be provided to the Authority for approval prior to installation.

11. Door Sensing: Any sensing of patron door(s) for open/closed status that may be required for system operation shall be provided entirely by the Contractor. The layouts and methods for door sensing shall be approved by the Authority in advance of installation.

12. Electromagnetic Compatibility:

    1. General Electromagnetic Compatibility Requirements.

       This Section describes the electromagnetic compatibility (EMC) requirements for all of the electronic and electrical equipment and subsystems that are to be provided, installed, and tested by the Contractor. All of the specified PA/VMS System equipment shall be designed, constructed, installed, interconnected, and tested to ensure electromagnetic compatibility with all Authority communications, and electrical subsystems.

       The Contractor shall provide and install the PA/VMS System electronic and electrical equipment using standard practices for electromagnetic interference/radio frequency interference (EMI/RFI) suppression and mitigation sanctioned by the communications and telecommunications industries. These practices shall include the implementation of appropriate, shielding, grounding, bonding, and electronic filtering methods and specialized wiring and cable installation techniques. Each item of electronic and electrical equipment to be provided and installed under this Contract shall be electronically inter-compatible with all other electronic and electrical equipment items planned to be co-resident onboard Authority vehicles.

    2. Radiated Electromagnetic Interference Requirements

       The levels of radiated electromagnetic interference produced by new electrical and electronic equipment onboard the required Authority vehicles shall remain below levels which cause any noticeable performance degradation or disruption to any existing or specified new electronic equipment or system performance, as determined by the Authority Project Manager. The levels of radiated electromagnetic interference produced by PA/VMS System equipment onboard the required Authority vehicles shall also comply

with the United States Code of Federal Regulations Title 47, Telecommunications (Federal Communications Commission Rules and Regulations), Part 15, for Class A (industrial) devices.

3. Conducted Electrical Interference Requirements

The levels of conducted electrical interference produced by specified new electrical and electronic equipment on power, communications, and control wiring onboard the required Authority vehicles shall remain below levels which cause any noticeable degradation or disruption to any existing or specified new electronic equipment performance, as determined by the Authority Project Manager.

E. Variable Message Signs (VMS)

1. General Description: A forty-(40) foot bus will require one (1) Variable Message Signs (VMS) for interior bus display. The VMS will be placed in the center ceiling area of the bus in the forward sector of the bus near the operator. The minimum display for the messages shall be 4-6" high, with twenty (20) 2-3" character positions. These display areas shall be clearly visible from all seating locations, from all secured mobility device locations, under all lighting conditions, clear of all glares, reflections, and other conditions. The sign shall utilize high efficiency red LED pixels. Design and construction of the signs shall be subject to approval by the Authority. Access shall be provided to clean and maintain the interior of the signs. The signs shall be made secure from vandalism and regular passenger exposure. The signs will also meet SAE J1455 durability requirements.

   In addition to displaying the next stop announcements the signs shall also display the standard "Stop Requested" message upon activation of the passenger stop request strip.

2. ADA Compliance: The internal display signs shall meet all ADA requirements for internal signage.

3. Sign Communications and Capacity: The sign shall be equipped with a serial communications port, an SAE J1939 port and sufficient control and data buffer capacity to store and display up to a 256 character traveling message. The current message will be readable over the VLAN and Cellular Gateway described in TS 79.9.

4. Environmental: The electronic signs shall be of a shock and vibration resistant type designed for use on public transit vehicles under alternating high and low ambient light conditions. (Shock and Vibration requirements of specification SAE J1455 shall be satisfied. Refer to paragraphs 4.9.4 and 4.10.3 of SAE J1455.) The housing shall be highly water resistant, tamper resistant and vandal resistant and shall be designed to avoid the buildup of internal condensation during drops in ambient temperature through the use of a thermostatically controlled heater.

5. Housing: The VMS sign housing shall be manufactured from a hard grade of aluminum and shall be finished with a black matte corrosion resistant anodize coating. The sign housing display cover shall be made of tinted, translucent (clear) polycarbonate window designed to avoid glare from ambient lighting. A matte or frosted finish on the window (fascia) will not be accepted.

6. Display: The display shall consist of a matrix of at least 120 x 7 (840) high-brightness red light emitting diodes (LEDs). The display area shall measure, at least 33 inches wide by, 4-6 inches high and shall provide displays of one line of 2-3-inch high characters. The maximum luminous intensity of each LED (pixel) shall exceed 1100 millicandles (mcd) at nominally 592 nanometers (nm) wavelength.

   The brightness of the sign shall automatically adjust to provide good readability under all normal lighting conditions and minimize windshield glare. Interior signs shall have a horizontal viewing angle of at least 160 degrees and shall have a minimum contrast ratio of 35:1 in all lighting conditions. Interior signs are to be visible throughout the bus.

   The Contractor shall perform a viewing angle analysis for all seated positions and secured mobility device locations, and shall perform a glare/reflection study, and submit for review as part of CDR 14.

F. Vehicle Computer Unit (VCU) and Vehicle Local Area Network (VLAN)

1. General Description: A processor on the vehicle (although substantial functions may take place in servers off-vehicle) called a Vehicle Computer Unit (VCU) shall facilitate proper operation of all vehicle PA/VMS System components over the Vehicle Local Area Network (VLAN) described in TS 76.5.

   Vehicle Computer Unit: The onboard computer shall input, assemble, compute, and coordinate all Global Positioning System (GPS) and Differential Global Positioning System (DGPS) vehicle location data, odometer data, route and stop data, and all other required PA/VMS data.

   The VCU must collect and store all of the necessary route topography, audio recordings and sign text for automatic operation of the PA/VMS system.

   Functions of the integrated PA/VMS System which shall be accomplished by the VCU shall also include:

   1. Obtaining and using Satellite Data (GPS) for Vehicle Position Calculation
   2. Obtaining and using Error Correction Data (DGPS) for Vehicle Position Calculation
   3. Obtaining and using Speed, Odometer and Gyro Data for Vehicle Position and Track Calculation (Dead-reckoning)
   4. Calculating and Tracking Vehicle Location and upcoming stops in Real Time
   5. Obtaining, Storing and Using Vehicle Route and Stop Data
   6. Providing Location driven Triggering for Announcements
   7. Providing on-Vehicle ADA Compliance: Visual and Audible Next-Stop and Destination Announcements
   8. Receiving and transmitting PA/VMS information from/to the Operator Control Unit (OCU):

(a) Receiving Vehicle Operator input data

(b) Providing information to the OCU for display

9. Receiving/Processing Door Contact Signals (as required)

10. Logging all ITS activity (whether vehicle itself is on or off) and transmitting logs to an Authority- approved off-vehicle repository (e.g., server or cloud data store) via WLAN or cellular connectivity. These logs should include but are not limited to:
    a) Operator logins
    b) Automated and manually-triggered announcements and visual PA/VMS displays
    c) Stop requests
    d) Stop activity such as a vehicle servicing a stop
    e) Vehicle location telemetry
    f) Timepoint traversals
    g) APC logs

11. Transmitting relevant data on the Vehicle Local Area Network (VLAN)

The VCU and all other major vehicle onboard electronic components shall be interconnected for data communications by way of a SAE J1939 compliant Vehicle Local Area Network (VLAN) as described in TS 79.5.

2. VCU Interface and Storage Requirements: VCU must be capable of interfacing with other nonproprietary vehicle communication components, including: Operator Control Unit (OCU), route and destination signs, voice and visual annunciators, Automated Passenger Counters (APC), and a mobile radio. Additional VCU interface and storage requirements are as follows:

- Store and display not less than three thousand (3000) unique visual messages without reprogramming, approximately 75 preprogrammed "public relations" messages, and displaying the current local time at predetermined time intervals.
- Capable of storing not less than thirty thousand (30,000) unique voice messages without reprogramming.
- Capable of interface with WLAN network at garages described in TS 79.4 and a cellular network described in TS 79.3.1 for broadcasting real-time data, receiving configuration changes, and sending log files to back-end systems off-vehicle.
- Capable of capturing and transmitting over the VLAN all operator identification, route and run information, current headsign information, ADA stop announcement data, GPS, DGPS and/or Electronic Tag position data, speed and/or odometer data.
- Capable of initiating all system and component diagnostics upon log-on and upon special maintenance inquiry at the OCU.

3. VCU Hardware Requirements: The VCU hardware shall at minimum meet the following standards and capabilities:

- Late model, state-of-the-art high speed computer processor
- Dual-channel high fidelity audio with built-in amplifiers

- Independent automatic volume control for each audio channel
- Ability to support the OCU and components connected to the J1939 LAN
- Compliance with SAE J1939 vehicle communications protocol
- Support for non-J1939 communications protocols as needed and approved in writing by the Authority, including the ability to add protocol support for non-standard electronics that may be present on, or be added to, transit vehicles
- Ability for Authority maintenance staff to use USB media to manually load new data or extract log files. Another mechanism may be proposed and approved by the Authority.

4. Vehicle Local Area Network: The Contractor shall furnish and install a Vehicle Local Area Network (VLAN) on each Authority vehicle in accordance with standards SAE J1939 and related standards as described in TS 79.5.

   The VLAN on each Authority designated vehicle shall be capable of connecting the following vehicle components or subsystems:

   1. Vehicle Computer Unit (VCU)
   2. Odometer, Speedometer and Gyro Sensors
   3. Operator Control Unit (OCU)
   4. Vehicle Subsystems Diagnostics
   5. Door Open/Close Sensors
   6. Route & Destination Sign(s)
   7. Vehicle PA and VMS Subsystem
   8. Vehicle Communications Subsystem(s) (Data)
   9. Passenger Counting Subsystem
   10. AVM Subsystem
   11. Fare Collection Subsystem
   12. Wheelchair Sensing Subsystem

The supplier must identify and describe in detail any communication links between modules that require a dedicated communication link other than the VLAN. In all cases in which SAE J1939 may allow deviations from the established standards, the supplier must receive prior authorization from the Authority. Accordingly, the Contractor shall identify and obtain Authority approval for any components being connected to the VCU that require a “dedicated communication link” other than the VLAN. Connectivity in such cases shall be fully described.

Fiber Optic VLAN

If a compliant J1939 VLAN can be implemented with fiber optic cable rather than copper conductors the Contractor shall obtain Authority approval to proceed in this manner with the VLAN installation.

Diagnostics

All PA/VMS components installed on the vehicle, including the VLAN, shall have extensive built-in diagnostics. Go/No-Go indications and failure codes shall be employed to indicate problems and their sources. Upon power up or upon programmed command, each component shall perform a self-test. Power-up self-test results shall be collected by the VCU, logged, and reported to the vehicle operator via Operator Control Unit (OCU). Each vehicle component on the VLAN shall, to the extent practicable, be able to perform fault detection and isolation to the board and/or module level. All PA/VMS components will make diagnostic information available on the VLAN so it can be read by the Cellular Gateway described in TS 79.8 and the Bus Mounted Data Recorder described in TS 79.10.

Installation

Components of the VCU subsystem and VLAN shall be installed on the designated vehicles. All power and communications connections shall be provided as required, using wires and cable suitable for the installation.

G. Automatic Vehicle Location Subsystem (AVL)

1. General Description: The Contractor shall provide an Automatic Vehicle Location Subsystem (AVL) as a critical component of the PA/VMS System. The AVL system shall include the equipment and software required for the automatic acquisition and processing of high resolution vehicle location data onboard the buses. Vehicle position data (Triggering) must be made available to the PA/VMS System and be readable over the VLAN at all times, above or below ground, while the vehicle is in service.

   In order to accurately determine vehicle location, the bus shall be equipped with a GPS antenna, GPS receiver-processor, a source of differential error correction (DGPS) and the Vehicle Computer Unit (VCU). The VCU shall be provided with a route-run database and appropriate location calculation (algorithmic) software to determine vehicle position. The VCU shall also be provided with appropriate connectivity and subsystems for receiving location related data from underground or above ground electronic transponders (see below), vehicle odometer, vehicle speedometer and any other source of data as required to generate the required vehicle position.

   While above ground, vehicle position data shall normally be obtained from a GPS receiver-processor; however, when below ground, or in GPS shadowed areas, the vehicles shall employ electronic tags (tag or loop), transponders or similar technology to obtain position input data. (see below) Vehicle motion data shall also be obtained as required from vehicle Inertial Position sensors (odometer, speedometer, and gyro). These position and motion data inputs shall be used by the onboard computer (VCU) to establish an updated vehicle position and to maintain a continuous Dead-Reckoning Track (DRT) of the vehicle's location.

2. Position Smoothing and Filtering: All external sources of position information (GPS, Tag, Loop, and Inertial) shall be used primarily to update the ongoing Dead Reckoning Track (DRT) of vehicle position. In turn, the PA/VMS shall derive its position triggering from positions on the DRT track.

3. Differential Error Correction (DGPS): The AVL subsystem provided shall utilize a differential error correction to improve the accuracy of the received GPS position. The methodology and components for obtaining the differential error correction shall be approved by the Authority prior to installation on the vehicle. Accuracy of the actual vehicle position output shall be within + 50 feet, 95% of the time, at the vehicle nose.

   An alarm shall be initiated if actual vehicle location information generated by the VCU exceeds pre-set parameters related to position.

4. In tunnels where no GPS signal is available, and where the MBTA or MassDOT have installed Bluetooth Low Energy 4.1 beacons for the purposes of location tracking. The VCU or related component shall use those beacons to determine the vehicle's position underground. The Authority will provide a lookup table associating a unique beacon identifier with a geographic coordinate. The Authority shall be able to remotely update and expand that lookup table without use of contractor staff.

H. Operator Control Unit (OCU)

1. General Description: An Operator Interface, called the Operator Control Unit (OCU), including microphone, input keypad and output display shall provide the essential PA/VMS interface to the vehicle Operator. The OCU shall be specifically adapted to transit operations and the vehicle Operator shall control all required PA/VMS functions through the OCU display and input device. With Authority approval, two OCUs (or another alternative arrangement) may be provided for interfacing with different PA/VMS functions (e.g., a CAD/AVL interface distinct from an interface that manages PA/VMS announcements).

   The Vehicle Operator Control Unit shall meet SAE J1455 environmental and durability requirements and shall provide as a minimum the following functions for the PA/VMS System:

   1. Provide audio output connections and signals from the Operator's microphone.
   2. Provide audio connections and control signals to the vehicle internal and external public address amplifiers.
   4. Provide selective PA/VMS Subsystem Maintenance Diagnostics
   5. Be capable of expansion to accommodate single operator log-on and other ITS subsystem functions, such as Radio, CAD/AVL, Fare Box, etc.

   The OCU shall have a set of dedicated function keys as approved by the Authority.

2. OCU Housing and Construction: The OCU enclosure shall be constructed of rugged aluminum and satisfy FCC Part 15 for shielding of EMI/RFI. The OCU keypad (if applicable) shall have multiple keys within a sealed, membrane-type material with no loose keys. A NEMA 4x enclosure suitable for transit operations is required. Keys shall be metal snap-dome type or equal. The exact number of keys required and their functionality shall be approved by the Authority.

3. OCU Display Unit: The OCU Display shall provide a digital display of at least 80 alphanumeric characters simultaneously, and in accordance with the following:

1. The display may use any display technology.
2. The display characters, however presented, shall be so sized as to present clearly visible signals to the vehicle operator when seated at the vehicle controls and not be visible to the patrons. The Contractor shall ensure that all Authority vehicle seat positions and display mounting site selections are such as to allow this requirement to be met.
3. The displayed messages shall be clearly visible to the vehicle operator in external ambient light conditions ranging from bright sunlight to complete darkness, including times when the vehicle operator is wearing polarized sunglasses.
4. Adjustable back lighting shall be employed, and the display shall include controls for both display and backlighting brilliance.
5. The display shall receive and display, as a default function, the time-of-day signal as generated and provided by GPS and the on-board computer (VCU). This time display shall take the form of "00:00 AM" with optional blinking colon.

4. OCU Input Device: The Operator Input Device shall provide multiple numeric/function keys (or an Authority-approved touch interface alternative) for Operator input of data, commands, and control functions. The keys shall be backlit, water and tamper proof, and inset key characters shall be embedded within the key body such that long-term wear and tear shall not obliterate the key characters. The Operator Input Device shall recognize and respond to operator entry of dedicated and data-expanded key commands such as:

    1. Log-on/Log-off function
    2. Route/Run information entry
    3. Annunciator Controls:
        (a) Safety/Regulatory Announcements
        (b) Activate Internal Announcements
        (c) Repeat Last Announcement
    4. Input Device Controls:
        (a) Increase/Decrease Screen Brightness
        (b) Arrow keys for Scrolling

I. Database Management, Recordings & Editing (DBR&E)

The Contractor shall coordinate with the Authority to confirm that all new bus communications systems work with the Authority's existing PA/VMS data. The Contractor shall provide evidence of systems integration and be in accordance with the requirements stated below. This integration requirement can be satisfied if the Authority's existing CAD/AVL data can be used to drive the new bus announcements.

1 General Description: The Authority requires software to access, update and modify all PA/VMS System database and software components. Training and documentation appropriate for the technology shall be included. The software shall allow MBTA to

program all visual and audio annunciators, and the destination signs within a single application or a set of applications. The proposed platform for these applications shall be submitted to the Authority for approval. All systems, protocols and software required by this system shall be free from any MBTA-incurred royalties or fees into perpetuity.

PA/VMS System recordings shall be digital and shall be capable of being recorded or amended by the Authority using nonproprietary digital voice recording equipment. The PA/VMS shall also have automated annunciation ("robovoice") functionality where the MBTA may provide a text file that the PA/VMS shall read out according to MBTA-provided pronunciation guidelines.

2. Central Recording Station: The Central Recording Station (CRS) shall provide an easy-to-use means to record announcement audio and to define route-stop structures, all within a single database. The CRS shall specify the OCU displays, and internal sign text and characteristics.

   The system shall include software (with a graphical user interface) and required hardware (if different from a standard Mac or Windows desktop computer) to configure the PA/VMS and send configuration or new audio announcements to buses via wireless download to the vehicle computer (VCU). In order to ensure the maximum flexibility of use, including easy and cost-effective integration of commercially available music and sound effects into public service announcements, the CRS shall capture all audio data in an industry standard format and vendor-proprietary hardware shall not be used.

   Manuals and training materials of professionally produced quality shall be provided. One day of training in the use of the CRS shall be provided as well as telephone and email support for CRS users during the warranty period.

3. Route and Stop Data Configuration: A database organization is required for bus stop related data. Geographical locations audio and text for various bus stops must be created and maintained in a database. A PC based GUI Database Management Program (DMP) shall be used. Characteristics of the DMP provided shall include:

   1. The DMP shall allow for creating and assembly of route and stop data.
   2. The DMP shall allow for maintaining and editing the route and stop data.
   3. Output from the DMP shall be in a suitable format for input to the vehicle computer (VCU), either as a flash card image or as an ASCII file to be wireless downloaded, or both. Typical data sets to be prepared include:
      (a) Route Variations and associated sign codes
      (b) Route & Destination audio & text
      (c) Stop descriptions, including stop audio & sign text
      (d) Depot Route Assignments
      (e) Bus Specific Parameters
      (f) Transfer audio & text
      (g) Public Service & Advertising audio and/or text

J. Testing and Acceptance

The Contractor shall prepare a **written test procedure** which when implemented shall demonstrate all specified and otherwise essential features and capabilities of the PA/VMS System provided to MBTA. The test procedure shall be submitted to the MBTA for review, comment and approval. Only an MBTA fully approved test procedure shall be used to demonstrate the PA/VMS System provided by the Contractor.

Although preparation of the test procedure shall be the responsibility of the Contractor, the procedure prepared shall treat the following subjects (as a minimum):

(1) Certification that the System provided is ADA compliant.

(2) Certification that the System is compliant with SAE J1939.

(3) Demonstration of Next Stop Audio & Visual announcements.

(4) Demonstration DGPS/AVL location based triggering of next stop announcements.

(5) Adequacy of the Vehicle Computer Unit (VCU) message storage capability.

(6) Capability to easily accommodate changes to bus stops and announcements.

(7) Insensitivity to traffic lane travel or traffic passing in lanes.

(8) Adequacy of announcement algorithm to accommodate "stop request" buzzer/signal.

(9) Ability of System to accommodate add-on announcements at designated locations.

(10) Adequacy of Next Stop "Operating Sequence" per specification.

(11) Adequacy of Operator's manual control and over-ride via OCU.

(12) Adequacy of audio speakers and automatic speaker volume adjustment.

(13) Adequacy of protection of System from EMI or from generating EMI.

(14) Adequacy of signage in terms of size, visibility, performance and ADA compliance.

(15) Adequacy of VCU to acquire, store and process all forms of System required data.

(16) Adequacy and performance of installed System diagnostics.

(17) Demonstration that accuracy of location is +/- 50 feet, 95% of all test readings.

(18) Adequacy of OCU for all functions and ease of handling by Bus Driver.

(19) Demonstration of Database Management, Recordings & Editing (DBR&E).

System Acceptance by MBTA shall be based upon Contractor's successful demonstration of the ITS provided, following the test procedure prepared by the Contractor and approved by the MBTA. Complete system integration with the Authority's existing Vontas system is required for acceptance of a production bus.

K. Equipment List

The Contractor shall reference this list to identify representative minimum requirements of the complete ITS/Communications system required to be installed on each bus. The table below is to be used for reference only and is not meant to define all necessary components. The Contractor is

responsible to identify all components required to fulfill their obligations of providing a system that meets all Technical Specification and Attachment 4 requirements and shall submit a complete system overview with a list of all equipment to be installed for Authority review and approval. The Contractor is responsible for providing a complete ITS system that is capable of meeting all requirements defined in the Specifications in this attachment and integrated with all bus systems and the existing MBTA infrastructure.

Item	Vendor P/N #	Description	QTY
1	75T0016-005	CABLE-MDT,5m	1
2	75T1289-001	CABLE-HARNESS,W1C	1
3	75T0897-020	CABLE TO TWIN VISION	1
4	75T0378-015	CABLE TO SUNRISE LED SIGN	1
5	-	CABLE TO FAREBOX	1
6	10T0545-001	ASSY-VI IVLU,XG-75M RADIO,DEAD RECKONING	1
7	25T0113-001	MODULE-TRANSIT POWER (24V TO 12V)	1
8	50T0035-001	BOXVONTAS	1
9	50T0009-002	DRIVER'S SPEAKER	1
10	45T0115-001	SIGN-INTERIOR LED,20 CHAR RED	1
11	25T0128-104	HANDSET (48" ARMORED CABLE)	1
12	24T0016-001	COVERT MIC	1
13	50T0052-001	HANDSFREE MIC	1
14	50T0120-001	CMDT II	1
15	61T0632-001	MOUNT-MDT	1
16	75T1290-001	CABLE-HARNESS,W1A	1
17	75T0988-001	CABLE-HARNESS,W1D	1
18	75T1291-001	CABLE-HARNESS,W2 (VIIVLU, RADIO POWER)	1
19	24T0486-002	ANTENNA-DUAL BAND (GPS/WLAN)	1
20	24T0028-007	ANTENNA-RADIO	1
21	75T0793-015	CABLE-GPS ANTENNA,15'	1
22	75T0793-115	CABLE-WLAN ANTENNA,15'	1
23	75T0558-025	CABLE-RADIO ANTENNA,25'	1
24	24T0058-001	COVERT SWITCH	1
25	75T1292-001	CABLE-POWER CONTROL MODULE	1